For the digitally perplexed,
the cartographically disoriented,
and the geospatially disadvantaged,
custom tailored for self-resuscitation
in the privacy of your own stateroom or berthing

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NAVIGATOR OF THE NAVY

INTRODUCTION

The purpose of this handbook is to help with the introduction of digital databases that will support the transition from maritime navigation relying primarily on paper products, to navigating in a digital environment. It is meant as an initial reference for information about Geospatial Information and Services (GI&S) as they relate to maritime navigation and support from the National Imagery and Mapping Agency (NIMA). This handbook is adapted from a previous handbook entitled "NAVAIR MC&G handbook".

This handbook will:

Help you understand the **relevance** of GI&S to your operations,

guide you in acquiring a basic **competence** in GI&S,

explain the process for you to **acquiring** NIMA GI&S **data and services**,

and point you to **assistance** on GI&S within NIMA, and elsewhere.

You don't have to read the whole thing front to back right away, if ever. We organized it for browsing. For more details on a particular topic see the

Where to find it:

box at the end of each section.

We recognize that you are busy, so we include an Executive Gouge that distills the essence of the handbook on two pages. If you read the Executive Gouge, and intuitively grasp the fundamental implications of each nugget of truth…well, you need read no more! Furthermore, you become a Geospatial Information Prophet and can grant audiences to those of dimmer wattage than yourself. You can then reveal to NIMA the next crisis area that will require mapping which is, of course, where our next war will be. If anyone needs to know, NIMA does.

If you now are beginning to wonder:

"Why is GI&S so important to your operations?"

– Please read on!

EXECUTIVE GOUGE

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SECTION I

DO YOU NEED GI&S SUPPORT FOR NAVIGATION?

Today, the United States Navy relies on paper charts for the full range of maritime navigation requirements. In the future, however, the Global Positioning System (GPS), in conjunction with digital chart data, will provide the necessary technology to support the Navy's move to electronic charting as a primary means of navigation. In this initiative, understanding issues such as: data base structure, electronic chart navigation, geodetic datum differences, and chart accuracy are key to a successful transition.

Continuous positional information & Electronic Charts PLOT WHERE YOU ARE VS. WHERE YOU WERE!

The common backdrop supporting Department of Defense (DoD) navigation and/or weapon systems and their development is spatially referenced data. The new navigation and weapon systems require *digital* geospatial information in increasing amounts, more quickly, and on varying media. So what do you know about this thing called *geospatial information*?

1. GEOSPATIAL INFORMATION. Geospatial information is 2- or 3-dimensional data referenced to the earth and its environment. Mapmakers (cartographers) give the information its meaning through formal representations that describe distances, direction, size, and relative position. Spatial objects, which vary in location or time, are either picture elements (pixels), points, lines, or areas (sometimes called polygons). Cartographers measure positions, encode features with coordinates, and further define these objects with attributes. They then store this data in a raster or vector data model for the warfighter's later use. This information will print or display as text, imagery, or accurate models of the real world. For maximum value to the warfighter, geospatial information (referenced in space) should be available wherever the Navy must operate, be highly accurate, continuously updated, and electronically delivered. Further, it needs to be displayed and manipulated using friendly software, on low-end personal computers. (Placeholder – Definition of 4Dcube)

These ideas comprise a new way of doing business and are identified as Geospatial Information and Services (GI&S). GI&S has replaced the term Mapping Charting and Geodesy (MC&G). Remembering the acronym is not important. Remembering that you will use and exchange GI&S data anytime and anywhere IS!

2. **NIMA.** NIMA was established on 1 Oct 1996, as a combat support agency and chartered to provide timely, relevant, and accurate imagery, imagery intelligence, and geospatial information in support of the national security objectives of the United States. NIMA is comprised of the following former agencies: Defense Mapping Agency (DMA), National Photographic Intelligence Center (NPIC), Central Imagery Office (CIO), all imagery support resources of the Defense Intelligence Agency, and resources of the Defense Airborne Reconnaissance Program and the National Reconnaissance Program associated with imagery exploitation and dissemination.

3. **THE ROLE OF CNO (N096).** The Navigator of the Navy, CNO (N096) is responsible for all Navy GI&S matters and validates and submits Navy's GI&S requirements to NIMA. Additionally, N096 operates a fleet of 8 survey ships that collect hydrographic and bathymetric data under the direction of Commander, Naval Meteorology and Oceanography Command (CNMOC). This represents a major contribution to GI&S source information for naval interest, along with data obtained from other sources, such as foreign nations. The digital databases constructed from this information will be fundamental to our new approach to navigation.

4. **INTEROPERABILITY.** Joint Pub 1-02 states: "Interoperability is the ability of systems, units, or forces to provide services to, and accept services from, other systems, units, or forces, and use the exchanged services to operate effectively together." Talk about a classic understatement with leading implications!

NIMA's goal for systems development is straightforward – joint GI&S interoperability in the battle space!

In order to ensure *Interoperability,* the DoD adopts standard formats for various types of data we use. The chart below identifies these formats. Later in the handbook we will discuss these formats in detail and explain what they mean to your operations. The point we want to convey is that there are standard DoD formats for GI&S data, By ensuring all Navy systems use **DIRECTLY** the standard data, you will be able to talk (in a charting sense) to the other units in company.

Raster = Raster Product Format (RPF)

Vector = Vector Product Format (VPF) Matrix = Gridded Data Text = Textual Data (ASCII, SGML)

By the way, RPF and VPF are not only DoD formats but they are also the North Atlantic Treaty Organization (NATO) standard formats.

5. **NIMA DATA IS THE STANDARD GI&S DATA.** DoD 5000 acquisition instructions and DoD Directive 5105.60 mandate that all new systems will use standard NIMA products. We also believe it is a good idea based on: COST, LIABILITY, and INTEROPERABILITY. From a cost perspective, standard data is free to military users. From a liability perspective, you depend today on the NIMA "seal of good housekeeping" for a paper chart; NIMA will provide that same "seal of good housekeeping" for their digital data. Lastly a single data format enables interoperability not only across all of DoD, but among all other NIMA products. This allows for a seamless transition from submerged to surface and overland operations and *reduces the potential for "friendly fire" incidents*.

6. **STANDARD DATA COMPARED WITH COMMERCIAL DATA**. The business of Geographic Information System (GIS) data has exploded in recent years. From ship navigation to agricultural applications, GIS data can be used to provide vital information that can ehance operations and support various tasks. For commercial shipping and recreational boating, the ability to obtain one's near real position time on the backdrop of an electronic chart has exploded in recent years. This has led to the proliferation of commercial chart data in a number of electronic formats. While it has taked several years to develop, worldwide coverage of NIMA Digital Nautical Chart (DNC) data is now available.

DoD's recent push to commercial standards, software, and hardware has led to much discussion on whether using commercial charting data is a viable option. The Navigator of the Navy fully endorses DoD's move to COTS; but when it comes to GI&S data, there is reason for concern:

COMMERCIAL MANDATE? YES! But BEWARE of COMMERCIAL DATA:

CONTRACTOR DATA
COSTs O&M,N dollars
Data support for emerging crisis CAN BE VERY $$$$
Every contractor's data format is different
Charts are produced by digitizing National (i.e. NIMA, NOAA) Chart Products
Notice to Mariner (NtM) information is copied from chart producers, then reissued
Beware of out of date Charts
Liability; vendors will NOT assume and cite "Not Fit for Navigation"
No infrastructure to collect new data, and perform new compilation; rely on Hydrographic Offices' (i.e. NIMA, NOAA) to make new charts
Could have multiple datums
May not have access to worldwide data; may not have worldwide portfolio
NIMA DATA in Contrast
Costs DoD to produce, but DATA IS FREE to the Fleet – No OPTAR needed
JCS Directs crisis support - Data is still FREE to DoD
Data is Interoperable across DoD and NIMA products
NtM issued based on worldwide exchange network for maritime safety info
Products are based on (Navy, NOAA and foreign government) data from surveys performed to International survey standards
NIMA has access to National assets
Liability; NIMA will certify data "safe for Navigation"
Single Datum - ALL digital data is WGS 84
Seamless database from submerged to surface; wet to hinterland
NIMA digitizes the data from the existing paper source, updates with NtM, and incorporates new survey and imagery data when available

Where to find it:

For information on NIMA see DoD Directive 5105.60, 11 Oct 1996 and read **NIMA Functional Manager's Guidance for the USIGS Community**. DoD Directives: http:/dtic.mil/whs/directives. Navy directives: http;/neds.nebt.daps.mil. For information on Navy GI&S talk to Mr. Paul Witmer, N0961BN3, at (202) 762-0265 [DSN 762], e-mail witmer.paul@hq..navy.mil or N096BN2, (202) 762-1003. For info on Survey Ships call CNMOC (N32), (228) 688-5003 [DSN 485], International / Inter-Agency Agreements. For Information on standard products order **NIMA Standard Hardcopy Imagery and Mapping Products** NSN 7643014402525 and NIMI 805-1A; of call Defense Supply Center Richmond – Products Support Line 1-800-826-0342.

SECTION II

GI&S REQUIREMENTS

1. **TWO KINDS OF REQUIREMENTS.** Two kinds of requirements exist in GI&S: Developmental (sometimes called functional) requirements and Operational requirements. They are different. Developmental requirements come from the service development commands such as NAVSEA and SPAWAR. The GI&S products that usually result are NIMA test data sets, product prototypes, and hardware/software related to development. On the other hand, Operational (or "area") requirements come from the Services, Unified Commands, and the JCS. Area requirements are defined in terms of the geographical regions where GI&S products are necessary to perform the mission (i.e. wherever you will STEAM). These go through a priority process that ensures NIMA produces the most important areas first. System developers must discuss with the warfighters and their GI&S support staffs early and often in the development process. If not, a system can deploy for which NO operational GI&S coverage exists. Amazingly, this has already happened, with embarrassing and costly consequences! There is no substitute for clear teamwork in GI&S.

> CNO & SYSCOMs identify needs for new types of products. The FLEET identify where we need them. Submit Area Requirements via MSG to CINC & FLT CINC; Info CNO Washington DC //N096//

2. **DIFFERENT DATABASE FORMATS**. Navy uses all types of NIMA data. For maritime navigation, a deliberate process was used to define a database format for safe surface and submerged navigation. A vector format was chosen over a raster format. Why? Two reasons: (a) at the time of the decision, and still today, vector format is the only format recognized by the International Maritime Organization (IMO) for use by civil shipping to replace the paper chart, and (b) the vector format offers technical advantages over the raster format. *There is a difference between the flavor of vector chosen by DoD and that chosen by IMO. What this means to the Navy is discussed in Section III.*

Before we go into the specific advantages of one data format over another, you need to understand the basic definitions.

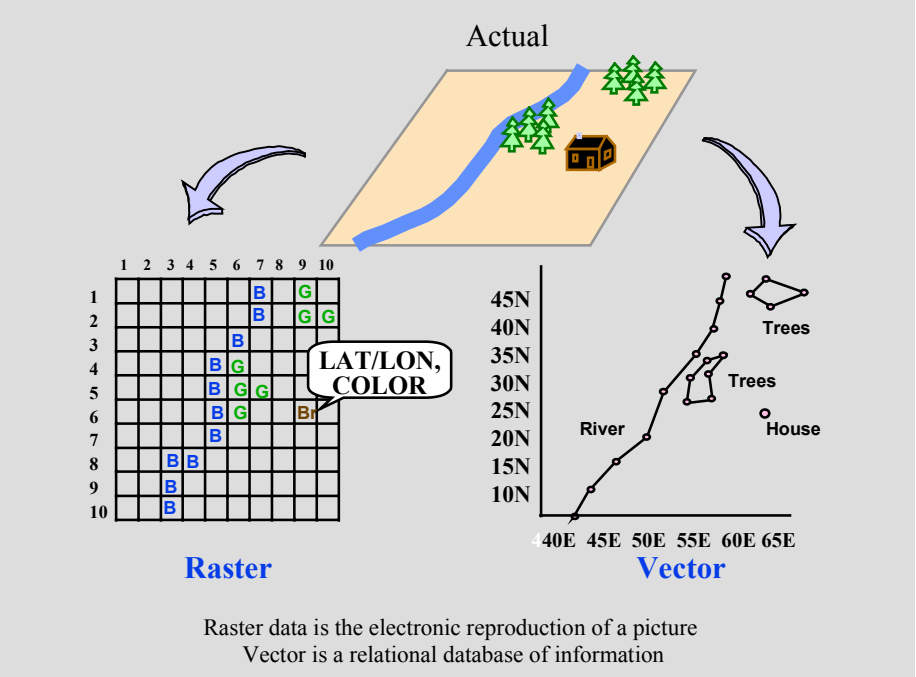
• Raster. The raster structure has a simple format of rows and columns of pixels. The pixel (short for "picture element") is the smallest non-divisible part of a digital image and is characterized completely by gray-scale brightness and/or color. The row and column of each pixel location determines the geospatial position. Excessive magnification of a displayed raster image degrades the visual fidelity and does not improve the content accuracy

Raster is like a facsimile – what you see is what you get!

• Vector. The vector representation, in contrast to raster's matrix of single-valued pixels, describes features objectively and subjectively in great detail. Vector data depicts features as points, lines, areas (sometimes called polygons), and text. The vector structure is more flexible that the raster data. At any magnification, vector data preserves feature content and retains maximum digitized positional accuracy. Vector format is not a simple data structure like raster; it requires a sophisticated data manipulation software to display the information.

Vector is like a word file – one you can manipulate!

The figure below illustrates the difference between raster and vector formats.



VECTOR offers powerful advantages!

Tonight's Top 10 list – 'Vector over Raster.'

RASTER	VECTOR
Is Cheaper to Produce	Is Smarter
Looks like a chart	Can look like a chart also
Cannot rotate for heading up display	Will do flips if you want
Zoom constrained by pixel size	Zoom is unconstrained (data density matters)
Symbols & text unchangeable	Symbols & text can be tailored
Color palettes hard to adjust	Color palettes corresponds to ambient light
No data query capability	Yes, there is query capability
Can not be decluttered	Declutters naturally
Clogs Comm Pipes	Fits through smaller Comm Pipes
No automatic grounding avoidance	Supports grounding avoidance

When vector products were first produced, the viewing software was not robust enough to make full use of the underlying database, and many of the renditions looked more like cartoons than charts. Today's charting software allows you to turn on some or all of the features from the vector database, allowing the display to mimic that of a paper chart. Since the symbols in raster displays are inseparably bound to the entire image, they cannot easily be manipulated; rotating raster charts yields inverted symbols and text. This does not occur with vector data, because the symbols and text are stored independently without respect to orientation. Thus, data features can be changed and displayed in any number of orientations. As you zoom raster displays, the data pixels become bigger or smaller to the point of being unreadable. Vector data remains readable while moving through successive scales. The ability to declutter (turn features On or Off) becomes increasingly important with the overlay of radar and sonar contacts on the chart data. Raster data includes all pixels of the image including the background color. Vector data just includes the lines, points, and area boundaries, thus taking up a lot less data storage space. This equates to faster screen refresh, and electronic transmission.

RUNNING AGROUND CAN RUIN ONE'S DAY - VECTOR DATA ALLOWS FOR AUTOMATED GROUNDING AVOIDANCE

A raster product is a single image with no associated database - what you see is what you get. On the other hand, the vector representation is a relational database, from which you can interrogate the data. This is a very significant advantage of the vector

data alone over the raster data when it comes to grounding avoidance. The raster data cannot support automatic grounding avoidance. With the vector data, the features (i.e., soundings and hazards) are stored in a relational database. Thus, a navigation system can alert a mariner of area and features that are a danger to your vessel based on user-defined ship's parameters (i.e. ship draft) and course. The software application literally drills down into the database and displays hazardous features or soundings at the best resolution of the data, no matter what scale is on the display.

Where to find it:

☞ Information on Vector see MIL-STD-2407(DMA) of 28 Jun 96 and Raster MIL-STD-2411 of 6 Oct 94. These can be downloaded from www.nima.mil or printed copies can be received from the Defense Automated Printing Service.

SECTION III

THE NAVIGATION DATA BASE AND ELECTRONIC CHARTING

In dealing with this new age of electronic charting, we need to distinguish between the underlying databases of geospatial information and the software and systems that will be used to access and manipulate them.

1. **DATABASES**. The following table represents the databases in production to replace the paper products you use today.

Digital Product	Paper Equivalent	Classification
Digital Nautical Chart (DNC®™)	General, Coastal, Approach, & Harbor	Unclassified
Tactical Ocean Data (TOD) 0	OPAREAs, Range markings	Distribution Limited
Tactical Ocean Data (TOD) 1	Bottom Contour (BC)	Confidential
Tactical Ocean Data (TOD) 2	Bathymetric Navigation Planning Chart (BNPC)	Secret
Tactical Ocean Data (TOD) 3	TBD	As required
Tactical Ocean Data (TOD) 4	HITS	Secret
Vector Database Update (VDU)	Notice to Mariners	Depends on product

Trademark or Registration of NIMA data does not make this commercial data! Why a trademark or registration? US law prohibits the domestic copyrighting of data produced with government money, but NIMA wants to ensure a commercial vendor does not copy the name. **Trademark or Registration ensures you get official NIMA data.**

Digital Nautical Chart (DNC®™). DNC®™ (referred to hereafter as DNC), *in Vector Product Format (VPF®)*, is a general purpose global relational database designed to support marine navigation and GIS applications. DNC is divided into 4 scales: General, Coastal, Approach, and Harbor. In the year 2000, NIMA completed digitizing their portfolio of over 5000 paper charts and distributed this new data as DNC. The DNC is available on 29 CD-ROMs covering the world. Listings of available CD-ROMs or new edition CD-ROMs can be found in Weekly Notice to

Mariners and NIMA's homepage. Appendix A is a graphic of DNC coverage available at time of this writing. **As we move to the digital world we will need to re-orient our thinking from individual chart numbers to a "data library" concept**. However, to ease the transition, the charts used as sources to build DNC are indicated on the cover of the CD-ROM and within the header of the database. With paper charts, there is data overlap, but when the data is digitized for DNC, the best resolution is used and cataloged in the library. This means that in some cases only parts of the individual paper chart is used.

So what's DNC anyway? DNC is composed of point, line, area, and text features. What's considered a feature? A feature is an object on a chart that is geo-referenced. Examples: point feature - Buoy, Fixed Light or Tower; line feature - Shoreline, Depth Contour or International Boundary; area feature - Anchorage, Explosives Dumping Ground, or Inshore Traffic Zone.

Data features are divided into "coverages." Think of coverage as a Directory or "Home File". Below is a breakdown of the DNC coverages.

Culture	Land features of human origin - Roads, Buildings, Industrial areas
Earth Cover	Topographic Shoreline, Islands, and Foreshore Boundaries
Environment	Ocean currents, Tides, and Magnetic anomalies
Hydrography	Depth curves, Soundings, Bottom characteristics and a new feature unique to electronic navigation – Depth areas
Inland Waterways	Inland hydrographic features - rivers, lakes, and canals
Land Cover	Shore features significant to navigation – Trees, Glaciers, Swamps, Marshes
Limits	Significant to navigation – Pilot boarding locations, Restricted maritime areas, and Traffic separation schemes
Navigation Aids	You guessed it! Marine navigation aids, Buoys, Lights, and Beacons to name a few
Obstructions	This is a no brainer! Rocks, Wrecks, Bridges and just about every feature that is considered a hazard to navigation safety
Ports	Unique features common in most ports – Breakwaters, Piers, Wharves, Jetties, Berths and Bollards

Relief	Topographic spot elevations and contours
Data Quality	Everything you wanted to know about the paper source chart or survey used in the compilation of the DNC. Provides historical data, edition, Datum information, and related notes
Library Reference	Small scale depiction of the Chart coverage for use in selecting a geographic reference position for viewing

Tactical Ocean Data (TOD). TOD, is a companion VPF product to DNC that will support safe submerged navigation and Fleet exercise Operating Areas (OPAREAS). TOD also comprises BC, BNPC and other classified products to support submarine operations. Remember interoperability? Since the features of DNC are not repeated in TOD, a common format is necessary so that the data is seamless as a submarine submerges and moves from using DNC data to using TOD data.

Vector Product Format Database Update (VDU). A key parameter in moving to electronic charting is the ability to update DNC electronically. In April 2000, NIMA and the Navy successfully tested this electronic update capability using a patch process. A patch process is nothing more that a computer file being replaced with 1's and 0's from a corrected file. Ultimately, NIMA will send these updates to the Navy electronically using SIPRNET/NIPRNET and Navy standard communication circuits. Additionally, the overlay and text annotation tool functions of an electronic chart system can be used to indicate the latest Notice to Mariners data. When DNC becomes operational by the Navy, the VDU process will ultimately replace the tiresome task of hand correcting Notice to Mariners data for every paper chart.

World Vector Shoreline Plus (WVSPlus®). A data set not included in the list of navigation data, yet important to naval operations. This product, a *VPF (can you see a theme developing?),* will contain the shoreline information, country boundaries, some general bathymetric coverage, and international maritime limits information. WVSPlus® can be viewed using NIMA MUSE/VPFVIEW software and other COTS GIS applications.

Symbology. You will notice that vector data has no symbols of its own. To ensure a standard display, NIMA developed a symbol set called Geospatial Symbology (GeoSym™). For nautical charts these symbols conform to the international standards established by the IHO. It is the task of system developers to integrate GoeSym into their system for cross mapping vector data with appropriate symbology.

2. **A REVOLUTION IS ABOUT TO TAKE PLACE ON THE BRIDGE AND IT IS CALLED ELECTRONIC CHART DISPLAY AND INFORMATION SYSTEM – NAVY (ECDIS-N).** The Navy and commercial industry is moving forward with electronic systems on the bridge. The Navy will leverage off the work done by the international community to assist us in the transition to a full electronic navigation bridge. Appendix B is the USN policy letter signed by CNO on 17 Mar 1998.

> Many say that ECDIS-N is the biggest advance in safety on the bridge since the introduction of RADAR!

3. **CHANGE MEANS NEW TERMINOLOGY.**

Safety of Life At Sea (SOLAS). A United Nations Convention in 1974 that has been voluntarily adopted around the world. This convention requires that a civil ship must carry an up-to-date chart to be in compliance. Today this is satisfied with paper charts, but IMO in November 1995 modified this to allow ECDIS equivalency (must be official government data [DOD=NIMA] and have updating). The Navy traditionally conforms to these same standards although not required to do so by law.

Electronic Chart Display and Information System (ECDIS). This is the new set of rules and performance standards that allow a civil ship to meet the 1972 UN SOLAS convention requirements with digital data and certified electronic systems. These rules represent the culmination of 10 years of work by several international organizations; as follows:

International Hydrographic Organization (IHO)	Chart content and functionality, and a data format
International Maritime Organization (IMO)	Minimum performance standards
International Electrotechnical Committee (IEC)	Testing standards

NIMA represents the Navy's interest on these organizations. The US Coast Guard and NOAA also represented the civil United States interests.

Navy is NOT BOUND by the U.N. SOLAS Convention, but we have used this work as a foundation for developing the ECDIS-N policy.

Using ECDIS as a foundation for the Navy's transition to electronic charts is a good idea. The inventory of Navy vessels is just a drop in the bucket when compared to over 80,000 civil ships expected to use electronic charts with an ECDIS. In conjunction with DoD's move to emphasize COTS software & hardware, it makes good business sense to use what's being developed for civil shipping. Secondly, these commercial standards have been in development for over 10 years by theIHO member maritime nations and have undergone rigorous testing. These standards provide a sensible path for the Navy to safely transition from paper chart navigation to utilizing digital charts and electronic systems.

SMART SHIP showed that these commercial standards can work for the Navy with small modifications

ECDIS-N. This is the term that we have established which defines the Navy's performance standard for ECDIS. The Navy will use ECDIS-N to transition to reliance on digital data to support maritime navigation. The only deviations from the commercial standards are limited to those items that are absolutely required by the military to perform its mission. Principally, these include:

(a) Mandate the use of NIMA data, which differs slightly from the international vector data transfer format stipulated in the IMO resolution, - Remember **INTEROPERABILITY**
(b) Support visual bearing and dead reckoning (neither is fully supported in civil shipping).

There have been concerns among many on whether the Navy's use of VPF format data over the International format referred to as S57 will bar a Navy ship from entering a foreign port. This is UNEQUIVOCABLY NOT TRUE. ECDIS-N has the data content, functionality, and symbology of other ECDIS: the data format differences are "transparent" to the navigator.

Having said this, NIMA is working with Navy to gain national and international recognition of DNC as applicable under the SOLAS Convention. NIMA, wanting to ensure that a tactical advantage would not be lost, requested the Navy's permission to release DNC for public sales. The Navy gave NIMA this permission in March 1998. NIMA has submitted a letter to the Commandant of the United States Coast Guard seeking their approval of using DNC, in lieu of the paper charts, in US waters. NIMA has lobbied the International Hydrographic Organization for a change to the ECDIS documentation recognizing the VPF as an acceptable format to meet the civil ECDIS specifications.

4. **NIMA SOFTWARE.** NIMA produces general purpose utility software to standardize the access of GI&S digital data.

Full Utility Navigation Demonstration Software (FUND). A Windows 95/NT based software suite designed to demonstrate the power of DNC for navigation. It is a demonstration GOTS software application that is not certified as "SAFE FOR NAVIGATION." FUND supports an interface to a GPS PLGR and some commercial GPS receivers using a NMEA 0183 interface. FUND closely matches most of the ECDIS performance specification requirements.

MUSE 2.0. Mapping, Charting, and Geodesy Utility Software Environment (MUSE) is a NIMA software application that can exploit NIMA raster and vector digital products across various hardware platforms and operating systems. MUSE includes source code, and will run on Macintosh, MS-DOS, Windows, and Sun UNIX platforms. Basic exploitation includes the capability to import, annotate, and simultaneously display different vector and raster products (such as CADRG, DTED, DNC, DAFIF, and WVSPlus®).

VPFVIEW. VPFVIEW is a module within MUSE to view NIMA's VPF data. You can select data from one or more databases for display by region, feature, or group of related data types. You don't have to load or convert the data: simply read it directly from the media (CD-ROM, hard drive, or diskette). It is not a Geographic Information System (GIS), so it has no analytical capability other than viewing and zooming data features.

5. **NIMA Maritime Safety Information Center -** http://pollux.nss.nima.mil has replaced the text oriented NAVINFONET and can link the user to information on:

General Information/Points of Contact

Geographic Locator (Region / Subregion)

Digital Nautical Chart® Home Page

US Notice to Mariners

NIMA Hydrographic Products Catalog

NIMA On-Line Navigation Publications

Marine Navigation Calculator

USCG Navigation Information

Broadcast Warning Messages

Anti-Shipping Activity Messages

ONI WorldWide Threats to Shipping

Mobile Offshore Drilling Units

See Section V for more details.

SECTION IV

NAVIGATION IN THIS NEW WAY

Technology is great, but as you can appreciate, there are some basic skills necessary to safely transition to an ECDIS-N; for starters an understanding of the Global Positioning System (GPS).

1. **WHAT IS GPS**? This is not a tutorial about GPS. In fact one of the best tutorials we have read is a Whitney, Bradley, and Brown, Inc. publication titled "A GPS Primer for Strike Warfare Operations." Don't be fooled by the title, understanding GPS is crucial to every warfare area. NIMA has produced a GPS Tutorial diskette set which can be ordered under NSN 7644-01-416-4051.

The operating concept of GPS is simply stated; if you know the exact location of 4 points and you know how far you are from each of these positions, then you can determine your location relative to these points in latitude, longitude, and height. GPS supplies three-dimensional position, velocity, and time information in all weather. The GPS reference frame is World Geodetic System (WGS) 84.

> GPS tells you where you are, but it's not a navigation system. GPS will change the way you NAVIGATE!

GPS provides two different levels of accuracy. With Precise Positioning Service, full accuracy is 10 meters Circular Error Probable (CEP) (50%) or 16 meters Spherical Error Probable (SEP) (50%). (Note that 16 meters at 50% equates to a PLGR display accuracy no better than .5 arc seconds.) Access to this encrypted signal is restricted to DoD.

With Standard Positioning Service, the accuracy is 40 meters CEP (50%). This signal is primarily for the civil community, but DoD can downgrade it in a crisis. (Note that 40 meters at 50% equates to a PLGR display accuracy no better than one arc second.)

GPS *receivers* give warfighters the option to output elevations and coordinates on many grids and datums, including WGS 84. Just because they are "coordinates from GPS," however, do *not* assume they necessarily meet the **HIGHEST** GPS accuracy. Understanding the health of the GPS satellite constellation and whether you are receiving the encrypted signal affects the accuracy of the positional readout.

2. **DIFFERENTIAL GPS (DGPS).** DGPS is the concept of comparing the instantaneous readout of a GPS set to known benchmark data (sometimes called "ground truth"). From this a continuous correction or differential can be calculated. Local area DGPS networks are designed to operate over a limited area (perhaps a 10-mile radius). Wide area DGPS networks are intended to operate over as much as a 1000-mile radius. Using DGPS the error can be decreased to the 1-2 meter range.

Accuracy depends on the original source of the coordinates, not the display device!

3. **A NEW WAY TO NAVIGATE**. I have been navigating for years, so why now do I need to know about DATUMS? By using GPS and positioning yourself continuously in terms of specific latitudes and longitudes, you have changed the way you navigate in a subtle way. Today, navigating in and out of port is performed relative to fixed landmarks. By shooting bearings and angles, positions are calculated using the intersection of the bearing lines taken simultaneously to multiple fixed objects, as depicted in the figure below. Thus, one seldom cares where the ship is in an absolute sense - i.e. exact numerical latitudes and longitudes in a global sense are not an issue.

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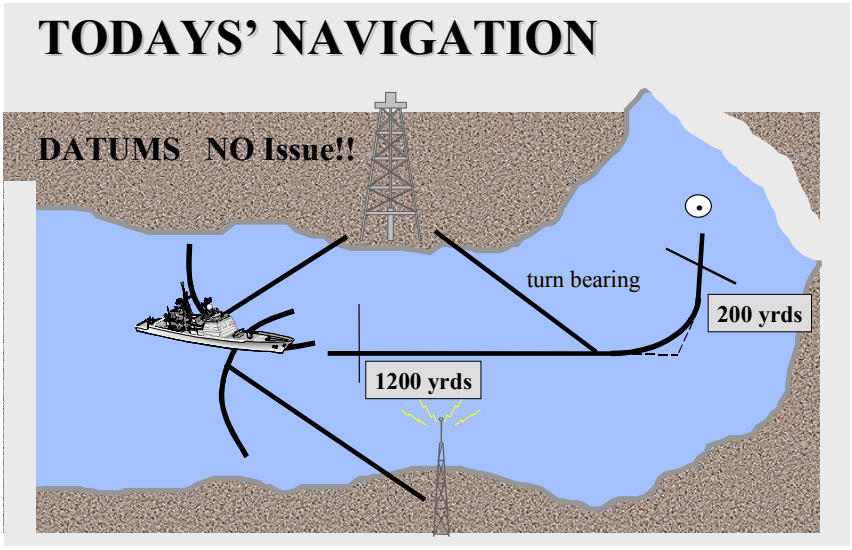


Even though you could estimate the latitude and longitude from your apparent position on the paper chart, the result may differ from the numbers found independently from GPS. Successful navigation with GPS requires that navigation and bathymetric features and landmarks on the chart be registered in the same geospatial reference frame as that used by the GPS and this raises the issue of datums. **Therefore if you navigate using GPS and your paper chart is on a different datum, you have a potential disaster on your hands.**

4. **DATUM**. *OKAY,* so what is a datum and how does it relate to what I do? A datum is a math model of the Earth's shape used as a basic reference to calculate position coordinates, heights, and distances, and also to make maps. The datum is made up of several components, but the most important is that a datum defines the point of origin from which all positions are referenced. For example the WGS 84 point of origin is the center of mass of the earth. The North American Datum (NAD) 27 datum is a world referenced to Meade's ranch in Kansas, roughly the center of the Continental United States. For the Tokyo Datum it is the world centered on Tokyo.

The only way you can know the datum of a paper chart is by a careful reading of the legend!

The only way you can know the datum of digital data is by a careful reading of the header information!

The DoD standard datum - and the one to which GPS defaults - is WGS 84, but there are hundreds of other datums worldwide. The measured difference between positions reported with respect to WGS 84 and these other datums can be up to 1/2 mile with reference to a continental port and a matter of miles with respect to isolated islands. Thus, traversing a channel using the wrong chart datum can spell disaster. Although NIMA produces all digital data in WGS 84, there are thousands of paper charts and even some electronic data in use today based on different datums. As one begins to rely on electronic systems for auto-piloting, understanding the provenance of the input data will be critical to safe navigation. The figure below shows the difference that a datum can make while navigating in a channel.

Actual Track

Intended Track

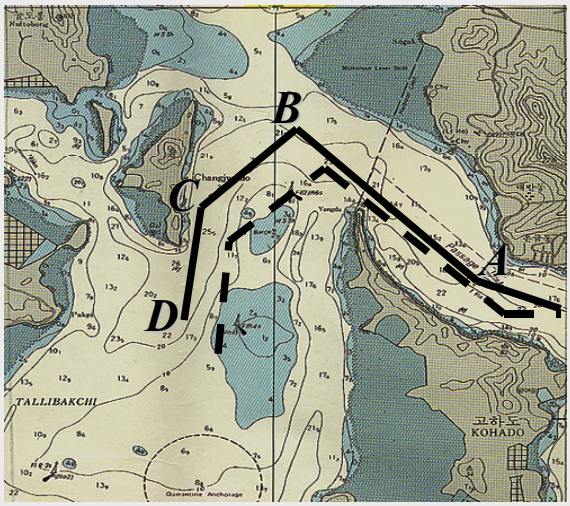
ACTUAL LAT/LON

A:34º46'23''/ 126º22'17''

B:34º47'12''/ 126º21'20''

C:34º46'45''/ 126º20'49''

D:34º46'11''/ 126º20'44''



Different datums will give different coordinates for the same location!

So you may think this is just theoretical, or does not apply to me. Wrong! Some recent examples:

In Lebanon, naval gunfire from the Battleship used WGS 72 coordinates, while Marines ashore used European Datum coordinates! Result, Naval gunfire was directed too close to friendly forces, and the target was missed.

During the Haitian crisis, a Navy ship found itself on a shoal (according to CNN 'anchored just offshore'). The visibility was low and positions were obtained using a GPS defaulted to WGS 84. However, the paper chart used for plotting position was based on the NAD 27 Datum with a difference in position when compared to WGS 84 of 100-200 meters. The plot of the ship's course looked good on the chart, but in reality the true track was directly over a charted shoal. Although the paper chart and GPS showed 2 different addresses for the shoal, the shoal, not caring about the datum, did not move!

A Navy ship in the Red Sea noticed that the GPS receiver and the paper chart differed by several hundred meters. The ship's crew thought that the GPS receiver was malfunctioning. Even though the METOC officer pointed out that the difference could be associated with a datum difference, the crew still believed that the GPS receiver was bad. So they CASREPed the GPS receiver, and requested a technician be flown out to the ship. Can you tell where this story is going?! You bet, the

technician got onboard and observed that, "the chart was in a local datum and the GPS display defaulted to WGS 84." After the GPS receiver was defaulted to the local chart – the position matched. OOPS!!!

Potential disaster lurks in the use of mixed datums!

5. **DATUM TRANSFORMATION.** NIMA software such as MADTRAN and MUSE, and most GPS receivers, can perform datum transformation. The key to safe and successful navigation is to ensure that your GPS receiver and the paper chart or digital display you are using to plot your position are using the same datum.

6. **THE SHAPE OF OUR EARTH.** My GPS receiver elevation display indicates my ship has just submerged! Should I sound the abandon ship alarm? Warfighters use height information in several varieties: barometric altitude (referenced to atmospheric pressure); MSL elevation, AGL elevation, radar altitude, contour values and spot elevations (all related to the mapped surface); geoid height (related to the bumpy, undulating physical model of the world's gravity); and the ellipsoid height (based on the smooth geometric model of earth).

Consider the relationship between good old Mean Sea Level (MSL) and the new kid on the block, GPS. Traditionally, MSL has been the zero height for our vertical datum. It's called *mean* sea level because it is based on the average rise and fall of tides over about 18.6 years of measuring (the length of the sun and moon cycles that influences tides). Each of the worldwide set of tide gauges was used to define a particular local vertical datum. At the time, there was no reason to tie in the local horizontal datum. In the recent past MSL was considered good enough, but scientists now know that the surface of the sea is not level everywhere. Contrary to common sense, water does *not* seek the same level, globally speaking, because of major gravity variations around the world. Rather, the water conforms to the equipotential surface of constant gravity – the geoid, our gravity model of the earth's shape. Better height measurements from satellite radar altimetry, using the Earth's center of mass as the point of origin, verify that MSL is a poor approximation of the geoid surface for our current needs. Typically, GPS receivers display elevation data referenced to the ellipsoid, not the geoid. So, you could find yourself in port in a geoid valley beneath the smooth surface of the ellipsoid model, and your GPS receiver will say the sea level is *minus* some number of meters, and it will be correct!

In some places, the ocean surface is 100 meters lower than elsewhere!

7. **UNDERSTANDING CHART ACCURACY COUNTS**. We have often been asked, "Where is my GPS chart?" and "Why are the charts no longer accurate?" A "GPS chart" does not really exist, and fundamentally the accuracy of the charts has not really changed. Before GPS, mariners knew that their estimate of geographical position could be in error by over a nautical mile, since the ship position was derived using various electronic systems and celestial navigation. With that degree of uncertainty, mariners gave wide berth to hazards depicted on charts, including shoals and obstructions. There was general acceptance of the idea that the available navigational information and cartographic process used by the chart maker to position the hazards were more accurate than the navigation means available to the user of the chart. With GPS providing a more accurate fix, the mariner now needs to pay close attention to the reliability of the chart, because the accuracy limitations of charts will now be critical to ship safety when GPS is used. For example, mariners may be tempted to become more daring, relying on their GPS to approach hazards depicted on charts more closely than prudent to save steaming time. This has already happened! However, the plotted hazards may have been positioned by less accurate navigation means than GPS and, in fact, may be significantly mispositioned.

From the mariner's perspective the chart has always been "accurate," now the chart he or she is using, not his or her navigation, may contain the errors!

GPS allows us to know one's actual position to a higher accuracy than the accuracy associated with the scale of the chart and often to a higher accuracy than the surveys from which the chart was made.

Specified Chart Accuracy. The NIMA accuracy for paper charts meets the National Map Accuracy Standard, originally based on human limitations in manually plotting information on charts. The NIMA specified accuracy for harbor, approach, and coastal charts requires that features plotted on a chart will be within 1 mm (at chart scale) of actual position with respect to the preferred datum at a 90 percent confidence level. The table below shows the relative comparison of 1 mm error at chart scale to GPS accuracy error. Remember since scale is a ratio -- small scale = large area.

Small Scale	1:80,000	± 80 M	> GPS error
Large Scale	1:15,000	± 15 M	≈ GPS error
Harbor Inset	1:5,000	± 5 M	< GPS error

In the case of a small scale chart, the chart error is the limiting factor in position plotting accuracy. The reverse can be true for large scale charts, such as the harbor plan insert. In this case, the absolute accuracy of GPS, rather than the chart limit the navigator's plotting accuracy.

In addition, the scale of paper charts force cartographers to generalize, and even displace, selected information on the map to preserve clarity. The inaccuracies associated with map generalization and displacement are no longer acceptable for new navigation and weapon systems.

Positioning of Survey Data. Errors in the underlying survey data will also affect accuracy. While NIMA makes every effort to produce the most accurate charts possible given the available data, the prudent navigator should approach shoals or isolated dangers with utmost caution, no matter what navigation method is used. Few coastal surveys of years past were possible to the accuracy of DGPS.

8. **DIGITAL DATA.** DNC and all other NIMA products are produced on WGS 84 datum. Currently, the primary information source is the paper nautical chart. Therefore, all paper chart accuracy cautions apply to DNC and other NIMA products when used for navigation and other applications, such as mission planning, command and control, simulation and training.

> Use of the most powerful hardware and software in the world to exploit GI&S data will not improve the original accuracy of that data, and can make it worse!

There are a number of efforts underway to use collected bathymetric and imagery data to provide higher accuracy for new edition charts. Additionally, the ECDIS-N policy letter includes a desired requirement to integrate the onboard fathometer to make all gray hulls bathymetric collection ships.

For digital displays of GI&S data, the same rules about projections and scales apply. Displayed vector data minimizes traditional projection problems for the warfighter. The data displayed at the moment uses a projection optimized for the location in view, rather than using a constant projection required for an entire map sheet. The positional accuracy of the displayed data is consistent and will not vary by location to the degree it would on a paper chart. The digital data will appear seamless along the display edges. The age-old problem of trying to edge-match chart sheets together vanishes with a digital display.

9. **MAGNETIC INFORMATION**. What happened to the compass rose? The magnetic variation derived from the world magnetic model (WMM) was printed on the paper chart. With the move to digital data and GPS, the WMM is embedded within the electronic chart software and GPS receivers. The WMM is updated every 5 years and the DoD global accuracy requirement is for no more than ±1 deg of degradation at the end of 5 years.

FUND calculates magnetic variation at any location by the click of the mouse

10. **CELESTIAL NAVIGATION**. Navigation by the stars, or heavenly bodies, is the oldest type of navigation still used today on all types of seafaring ships. Some consider it an art to be able to "shoot stars" with a sextant and then reduce these observations to a pinpoint navigation fix. Art or not, it takes a true professional navigator to complete the process from identifying which stars to observe, and to compute a navigation fix. Accurate observations and calculations are the keys to success.

System to Estimate Latitude and Longitude Astronomically (STELLA). STELLA, Version 2.0, is a software package developed by the United States Naval Observatory to assist the busy navigator by taking advantage of today's computer systems.

STELLA is configured to run on Windows 95, 98, 2000 & NT.

But is available only for authorized users.

Based on several new, improved, more accurate mathematical approaches to celestial navigation, STELLA provides the following functions:

ALMANAC	Calculates data published in the Nautical Almanac
POSITION UPDATE	Dead reckons a vessel track
RISE/SET/TRANSIT	Gives times of rise/set/transit of Sun/Moon
SIGHT PLANNING	Provides star visibility tables with a sky diagram
GYRO/COMPASS ERROR	Determines the gyro/compass error
SIGHT REDUCTION	Determines fix from sextant altitude observations

11. **MILITARY GRID REFERENCE SYSTEM (MGRS)**. Why do I get positions from the beach that are not in lat/long? The most familiar coordinate reference system is latitude, longitude, and elevation. Others include the two-dimensional Universal Transverse Mercator (UTM) and Universal Polar Stereographic (UPS) grid systems. Simply put, NIMA overprints these rectangular grids on maps to identify a location in rectangular coordinates – without converging meridians or the lengthy description of degrees, minutes, and seconds of latitude and longitude. The grids also simplify distance measurement. Grid units are always meters. MGRS is an alphanumeric shorthand for expressing UTM and UPS coordinates with fewer numbers. The basis for MGRS is the 100,000 meter grid square two letter identifier.

MGRS is used to support Naval Surface Fire Support (NSFS). Today the Mark 86, using the SPQ-9, illuminates a position on the beach to initialize the position of the gun. Then MGRS coordinates are radioed in from the beach and the Mark 86 computes the gun solution. As we automate this process, you will need to ensure that the routines used within the Mark 86 are able to properly perform the calculations of datum transformation and coordinate conversion.

Future NSFS will involve the use of GPS guided rounds. When the Navy moves to this weapon, conventional charts will no longer be sufficient to put these weapons on target.

Where to find it: ☞Order **DoD WGS 84** from NIMA and ask for NIMATR83502WGS84. Remember it includes MADTRAN, which also can be downloaded from NIMA's homepage. ☞Order **Coordinate Selection Guide** from NIMA using stock number DIAXXCOORDGRAPH. ☞For more information on precise positioning order **All You Ever Wanted to Know and Couldn't Find Out About Precise Positioning,** NIMA Stock No. Info Presiepos, ☞ For information on STELLA contact the USNO (202 762-1447) [DSN 762].

SECTION V

HOW TO GET NIMA ONLINE AND PRODUCTS

1. CHECK IT OUT! THE NATIONAL IMAGERY AND MAPPING AGENCY MARITIME SAFETY INFORMATION CENTER WEB SITE :.

The National Imagery and Mapping Agency (NIMA) **Maritime Safety Information Center Website** provides worldwide remote database query access 24 hours a day. Available databases include: Chart and Publication Corrections, NIMA Hydrographic Catalog Corrections, Chart and Publication Reference Data (current edition number, dates, title, scale), NIMA List of Lights, USCG Light Lists, WorldWide Navigational Warning Service (WWNWS) Broadcast Warnings, Maritime Administration (MARAD) Advisories, Department of State Special Warnings, Mobile Offshore Drilling Units (MODUs), Anti-Shipping Activity Messages (ASAMs), World Port Index, and Radio Navigational Aids.

Publications made available include: U.S. Notice to Mariners, U.S. Chart No. 1, The American Practical Navigator (Bowditch), International Code of Signals, Radio Navigational Aids, World Port Index, Distances Between Ports, Sight Reduction Tables for Marine and Air Navigation, Radar Navigation Manual, and the Maneuvering Board Manual. There is also a Marine Navigation Calculator. The 35 different online calculations focus on logarithmic and trigonometric functions, celestial navigation, distance, time measurements and conversions, weather data conversions, and the sailing's. The Maritime Safety Information Center Website can be accessed via the NIMA Homepage (www.nima.mil) under the Safety of Navigation Icon or directly at http://pollux.nss.nima.mil. Any questions concerning the Maritime Safety Information Center Website should be directed to:

MARITIME SAFETY INFORMATION CENTER
ATTN: NSS STAFF ST D 44
NATIONAL IMAGERY AND MAPPING AGENCY
4600 SANGAMORE ROAD BETHESDA, MD 20816-5003
Telephone: (1) 301-227-3296 or DSN 287-3296
Fax: (1) 301-227-4211 E-mail: webmaster_nss@nima.mil

2. **BASIC INFORMATION**. The distribution of NIMA products was transitioned to the Defense Logistic Agency (DLA) on 1 April 1998. This transition is intended to be transparent to the fleet. The Navy should use the Defense Logistics Standard System (DLSS) tto order charts using National Stock Number (NSN) and standard MILSTRIP guidelines. There will be some classified products that will not use NSN but will continue to use the NIMA stock numbers. These products will be indicated in the catalog.

DoDAAC. You need a DoD Activity Address Code (DoDAAC) to order GI&S products or subscribe to products routinely on automatic distribution. (The DoDAAC connects to the official clear text address of a DoD activity.) Navy DoDAACs start with either an N, V, or R followed by the 5 digit Unit Identification Code (UIC). Supply understands DoDAAC's, since they already use them to handle all incoming requisitions, bills, and supplies. You will need to know with some precision what product you want (its NSN), if it's available, how many of them you need, and by when. Finally, you need to know the priority based on the schema outlined in the current NIMA catalogs. As we move into the digital world, ordering of products does not change. Although digital data is distributed on CD-ROM, each CD-ROM contains a stock number.

Order Digital Data the Same Way you Order Paper Charts!

Automatic Distribution. You can set up a subscription to your account if you want predetermined quantities of new or revised products automatically. As the data goes digital, this makes most sense since now you can literally carry the world in a shoebox. Since there will be only a small number of CD-ROMs to support your navigation needs, we recommend you put yourself on worldwide distribution of DNC, and TOD (as applicable). *Be sure to alert supply that GI&S data must be distributed to you upon receipt or it may end up on the stock shelves!*

Correspondence Address
Defense Supply Center Richmond
Attn: JNA or JNB*
8000 Jefferson Davis Highway
Richmond, VA 23397-5516

Customer Support
1 800 826-0342
Defense Supply Center Richmond

web site
www.dscr.dla.mil/pc9

* JNA for CONUS Requests
JNB for OCONUS Requests
DSN 695
fax
JNA (804) 279-6545
JNB (804) 279-6524

Crisis or Emergency. There have been questions regarding the ability of DLA to handle "Crisis" or "Emergency" requisitions. The capability is exercised on a daily basis, when a ship, or system is covered by a CASREP, which can be used to express a high priority requisition. "Crisis," as defined by JCS, puts lots of assets to work on solving the current situation, and procedures are in place during crisis planning and execution phases to deliver whatever materials required to the appropriate players. "Emergency" is defined as short notice operations, such as a deployment to support humanitarian operations or other without-notice contingencies. Routine deployments are not considered crisis or emergency.

3. **PORTFOLIOS OF CHARTS FOR DEPLOYMENT**. Ships requisitioning a portfolio of charts for exercises or deployments cannot use the –series all- designator with NSN. However, the –series all- designator may be used with NIMA standard stock numbers. The –Use document- identifier must be coded as –A0D- for the DLSS to accept the NIMA stock number. A ship must be in a pre-commissioning status or getting ready for deployment to request permanent or deployment allowance activation IAW fleet directives.

4. **NIMA COMBAT ELEMENTS.** NIMA combat elements will become DLA facilities with NIMA personnel working Remote Replication System (RRS) and other issues. You will still be able to get limited distribution though these elements.

Where to find it: ⌲ NIMA Maritime Safety Information Center is on the internet at http://pollux.nss.nima.mil/index/index.html or may be accessed via the Navigator of the Navy web site – www.navigator.navy.mil . ⌲Another site of interest on Maritime Safety is the US Coast Guard site at www.navcen.uscg.mil. ⌲For information on specific products see the following specifications: DNC MIL-PRF-89023, May 1996, WVSPLUS MIL PRF-89012A,TOD MIL-PRF-89049/10 (still in draft), and VPFS MIL-STND-2412 and MIL-V-89045 which can be downloaded from www.nima.mil, or ordered from the Defense Automated Printing Service.

SECTION VI

HOW TO GET GI&S TRAINING

1. **DEFENSE MAPPING SCHOOL.** The Defense Mapping School (DMS), located at Ft Belvoir, Virginia is a training asset of the National Imagery and Mapping Agency (NIMA). NIMA is a combat support agency of the DoD, and is charged with providing direct support on matters concerning Geospatial Information and Services (GI&S) to the Office of the Secretary of Defense, the Chairman of the Joint Chiefs of Staff, Unified and Specified Commands, Military Departments, and Defense Agencies.

DMS is tasked to meet the needs of the Services for training personnel in GI&S, and enhancing individual and unit skills in the application of GI&S as a force multiplier.

2. **MISSION OF DMS.** DMS trains GI&S skills identified by the Services as essential for technically related occupational specialties or ratings required by officers and enlisted personnel in entry and advanced level GI&S functional areas.

3. **ORGANIZATION OF DMS.** DMS is organized into 2 branches, the Military Training Department and the Imagery and Geospatial Information Department. The Military Training Department teaches terrain analysis, geodetic survey, geographic information systems, photolithography, the remote replication system, printing and associated equipment repair, as well as, specialized GI&S management topics for the military. The Imagery and Geospatial Information Department focuses on training skills in geographic information systems, photogrammetry, multispectral and hyperspectral imagery to assist in the production and utilization of geospatial information.

4. HOW TO REQUEST DMS TRAINING. All DoD units and schools are eligible to receive DMS training. Resident Training can be requested through through your detailer or by calling the DMS registrar at Commercial: (703) 805- 5998 / DSN: 655-5998. Mobile Training Teams may be requested by calling DMS operations at Commercial (703) 805-2237 / DSN 655-2237 or by visiting the DMS website at www.nima.mil/NIMC/DMS.

5. **TRAINING PROVIDED**.

RESIDENT TRAINING. DMS offers over 40 courses covering geospatial subjects. These training courses range from general geospatial topics to highly technical applications. General topics provide a higher level or managers overview of subjects. Technical courses address more specific issues with geospatial applications and data. Below are some courses from the DMS catalog. The DMS catalog can be viewed online at the DMS homepage (www.nima.mil/NIMC/DMS)

General Resident GI&S Training

Navy Geospatial Information & Services Staff Officer Course (2 Weeks) Designed for Naval METOC and USMC Intel personnel; provides user with GI&S fundamentals, hands-on instruction in digital geospatial information exploitation and imagery fundamentals relating to exploitation of geospatial information. Introduces the student to the various NIMA products, how to procure them and methods of exploitation. Also provides basic concepts of Foundation Data and Digital Nautical Chart.

Introduction to Geospatial Information (1-1/2 Days) To provide personnel with an overview of basic geospatial information concepts and applications using Remotely Sensed Imagery (RSI) and Geographic Information Systems (GIS). Topics include the following: Theory, concepts and principles of geospatial information, Geospatial information and services, Introduction to image interpretation, Standard NIMA products, Demonstration of mission-driven applications, Concepts of Foundation Data (FD), and Examples of products created using spatial data.

Topographic Operations Management Course (10 days). To provide Marine Corps and Army platoon leaders and managers with an overview of the fundamentals of geospatial information and introduce students to the skills and challenges of managing any topographic platoon and doctrinal Geospatial Information & Services (GI&S) Support to Joint, Army and Marine Corps Operations. Formerly Mapping, Charting & Geodesy Officer Course (MC&GOC), the first portion of the course includes the fundamentals of Geospatial Information & Services (GI&S), joint and Service topographic doctrine. The second part of the course is focused on managing the technical functions of topographic support: Survey, Topographic Analysis, Cartography, and Reproduction operations. The primary blocks of instruction are: NIMA's Paper and Digital GI&S Standard Products, Foundation Data (FD) Concept, Global Positioning System (GPS) and the Precision Lightweight GPS Receiver (PLGR), Remotely Sensing and Geographic Information Systems, Managing

Topographic Support Operations, and Quick Response Topographic Products.

Advanced Technical Geospatial Subjects

Remotely Sensed Imagery (5 Day) To provide students with the skills needed to accomplish commonly encountered tasks associated with Multispectral image interpretation, analysis and product generation. RIS Education based on Commercial, Multispectral Imagery using Erdas Imagine 8.4: Imagery concepts and sources overview, Imagery importing and preparation, Multispectral Image Interpretation and an introduction to Hyperspectral Imagery concepts, Digital Image Processing, Land Cover Classification using MSI, Terrain Visualization, Analysis tools, and imagery annotation and product generation

Remotely Sensed Imagery and Geographic Information Systems (10 Days) To provide familiarization with the concepts, theory, principles and applications associated with RSI and GIS. RIS & GIS Education based on Erdas Imagine V8.0 and ArcView V3.2 exploiting commercial imagery and standard NIMA Digital Data: Theory, concepts, and principles of RSI/GIS, Data import, digital image manipulation, enhancement, and categorization, Positional and thematic accuracy, data source merging and exploitation, Digital data formats and structures (raster and vector) and hands-on, mission-driven exercises, Overview of the concepts of spatial data and GIS, Concepts of Foundation Data (FD), Concepts of spatial data structures and models, Spatial analysis using vector & raster layers of information, NIMA digital data import and export and Hands-on GIS practical exercises.

Geographic Information Systems (5 Days) To provide a familiarization of Geographic Information Systems (GIS) analysis functions and applications. This GIS Education is based on ArcView 3.2: Theory, concepts, and principles of Geospatial data manipulation and exploitation, concepts of data structures and models, spatial analysis using vector & raster layers of information, and NIMA digital data import and export. The focus of this class is hands-on GIS mission-driven exercises.

Geospatial Digital Data User's Course (5 Days) To provide users an overview of NIMA Standard Digital products, digital data product structure, availability, and Government Off The Shelf Software (GOTS)/Commercial Off The Shelf Software (COTS) software to support Geospatial Analysis. The material will be focused on military users. Topics include: NIMA digital products, data availability and acquisition, datums, grids, projections, file formats for raster and vector data. Includes lessons on obtaining data from the NIMA gateways and loading it in geospatial programs for analysis and display.

Introduction to Nautical Cartography (5 Days) To provide instruction in nautical chart compilation for those involved in the creation of standard NIMA hydrographic products. Primary blocks of instruction include: Fundamental characteristics, marine navigation, electronic charts, quality control, source selection and analysis, hydrographic & topographic portrayal, aids to navigation and notice to mariner (NTM) updating.

Precise Positioning Orientation Course (1 Day) To provide fundamental geospatial knowledge essential for successful precise positioning applications, especially for targeting and navigation of Global Positioning System (GPS) aided munitions. The basics of Precise Positioning with primary emphasis on application. The primary blocks of instruction are: Introduction to Precise Positioning, Overview of the Global Positioning System, Introduction of the Photogrammetry of Precise Positioning, Accuracy Concepts for Precise Positioning, Coordinates, Proper/Improper Coordinates Sources for GPS-Aided Munitions, and Hardware/Software Systems Available for Precise Positioning.

Advanced Geospatial Applications

Advanced ArcView Using NIMA-In-A-Box (NIB) (1 Day) The class covers using Vector, Raster, Matrix, and Text data in ArcView using a set of pre-established extensions for dealing with NIMA data. Practical Exercises and Lectures focus on how to obtain data sets, how to use data sets, operating buttons & tools of NIMA in a Box. The class shows how to establish multi-scale data sets and build a local "NIMA-in-a-Box" project for ArcView Software is demonstrated.

Advanced ArcView Using Raster Data (1 Day) This class starts with a refresher to ArcView 3.2 followed by lectures and Practical Exercises concentrating on the use of raster data. Topics include standard NIMA raster products, data sources, data creation and export in ArcView, use of the RPF/VPF and RasterMap tool extensions and using the Spatial Analyst to conduct geospatial analysis of raster data sets.

Advanced ArcView Using Vector Data (1 Day) This class begins with a refresher to ArcView followed by lectures and Practical Exercises on Vector Product Format (VPF), Interim Terrain Data (ITD), Linking and Joining ArcView tables, using legends and labeling features, symbolization of data, and use of the VMAP and DNC Symbolizer extensions.

Advanced Geographic Information Systems (5 Days) Advanced GIS training based predominately on ArcInfo 8.0 and ArcView. Topics include: advanced spatial

querying techniques using vector overlays and proximity analysis along with comprehensive raster cell-based methods; Comparisons between the command-line ArcInfo workstation application and the ArcMap, ArcToolbox, and ArcCatalog GUI desktop applications; Production of map compositions w/ArcMap; Data creation through digitizing, editing, updating, and value-adding vector data; Advanced vector topological modeling with dynamic segmentation and regions; Introduction to Arc/Info's GRID and TIN modules of raster and terrain modeling, respectively; Linear network modeling through the use of ArcView's Network Analyst extension; Using Arc/Info Macro Language (AML) (current) and Visual Basic (future) to automate operations; and Examination of the benefits of using imagery and digital image processing in a GIS through the use of ArcView's Image Analysis Extension.

ARCView (1 Day) Concepts of the ArcView Geographic Information System, ArcView techniques for displaying and querying data, building maps and layouts. Training data sets are NIMA's Digital Nautical Chart and Urban Vector Map products in Vector Product Format. Serves as an introduction to this popular Geographic Information System.

Digital Exploitation of Coordinates (2 Days) To provide operator training using the RainDrop software and the Digital Point Positioning Data Base (DPPDB) imagery product to generate precise coordinates for positioning applications, especially for targeting and navigation of Global Positioning System (GPS) aided munitions. Topics include the basics of RainDrop software with primary emphasis on application. The primary blocks of instruction are Intro to RainDrop, Installation, Environment Manipulation, Menu Functions, Point Mensuration and Indirect Point Transfer Theory.

FalconView (1/2 Day) Introduce students to the FalconView data viewing application of the Portable Flight Planning System (PFPS) system. FalconView is a multi-media mapping package for the PC, displaying various types of maps and geo-referenced overlays. FalconView displays products in the Raster Product Format (RPF) and DTED level 1.

Hyperspectral Data Exploitation Course (5 Days) To train students in the basic theory and fundamentals used in the processing, interpretation, and exploitation of hyperspectral data. This course will teach the extraction and analysis of spectral signatures using hyperspectral data. ENVI and COSMEC software are used to train various processing methodologies for hyperspectral data, to include: data import, atmospheric correction, data reduction and noise removal, spectral classification, matched filtering, spectral un-mixing and anomaly detection. Students will be given a

final problem to solve, allowing them to practice the concepts learned during the class.

Introduction to ArcInfo 8 (3 Days) To provide a conceptual and hands-on introduction to ArcInfo GIS v. 8 software using the ARCTOOLS Graphical User Interface (GUI). Students will learn procedures for creating, displaying, editing, plotting, and analyzing spatial and attribute data using ESRI's ArcInfo GIS software. Focus will be on the ARC, ARCPLOT and ARCEDIT applications using the ArcTools software. This course will be presented using the Windows NT operating system.

MapInfo (1/2 Day) To provide students with an introduction into the MapInfo application. This introductory-level course will teach the basic operating principles of this geospatial information program. Students will learn how to open tables, create and save workspaces, use all toolbar functions, and receive an introduction to intermediate-level problem solving techniques. Includes the use of MapInfo with standard NIMA data.

COMPUTER BASED TRAINING. DMS has developed a two CD computer based training course that covers Geospatial Fundamentals Training. This self-paced computer course will provide an introduction to the fundamentals of geodesy, remote sensed imagery, geographic information systems, NIMA digital products, product ordering, product accuracy, and the global positioning system. This CD set (NIMA Ref: TRNGXGISFUNDCBT) is available through your normal supply chain from the Defense Logistics Agency using National Stock Number 7644-01-491-5152.

MOBILE TRAINING TEAMS. DMS deploys mobile training teams to formal service schools and units to deliver tailored GI&S classes as requested. This training exposes the Operating Forces to relevant issues, which can impact successful mission planning, navigation or targeting. Mobile training teams are available to support units worldwide, with requesting units providing travel and per diem costs. Resident Courses that can be given as an MTT are:

- Precise Positioning of Coordinates and Digital Exploitation of Coordinates.
- Remote Sensed Imagery.
- Geospatial Information Systems.

In addition, DMS has designed a modular set of lessons for mobile training targeted to customer needs:

Geospatial Information & Services for the Warrior (1 to 3 Days)- This is a modular set of classes that can be tailored to the needs of the customer it can last one to three days and cover the following subjects at the request of the customer. Target audiences are Engineers (Civil, Combat, and Geospatial), mission planner's, intelligence and operations personnel, navigators, targeteers, security police, staff personnel, and anyone who works with GPS or Geospatial Information and Services. The modular topics are:

GI&S Fundamentals:

Datums and Coordinates: Using a different datum can result in a shift of several hundred meters on the ground for the same coordinates. Discover what a datum is, and its mission impact. Included is a quick discussion on different coordinate systems (latitude-longitude, UTM, and MGRS). (1-1.5 hours)

Product Accuracy: Operations can suffer mission degradation from improper usage of NIMA products. We cover the terminology, use, and accuracy of various geographic products and their intended usage. Additionally, we cover targeting issues addressed by NIMA. (1/2 hour)

Introduction to Global Positioning System (GPs): GPs is a revolutionary way to navigate and deliver munitions. We cover the basics on how the satellite constellation works, common GPs terminology, vulnerability, uses and how GPs accuracy relates to maps and charts. (1 hour)

Introduction to Remotely Sensed Imagery/Geographic Information Systems (RSI/GIS): An overview of basic geospatial information concepts and applications using Remotely Sensed Imagery and Geographic Information Systems. (2 hours)

NIMA Products and Services:

NIMA Digital Products: Learn the different capabilities, attributes, limitations, and coverage between digital data types (raster, vector, matrix, textual). Provides an introduction to various Digital Product lines. (1 to 2 hours)

Downloading NIMA Digital Data: Surf the NIMA Open Source Information Server (OSIS) or SIPRNET websites and learn what data is available via these servers as well as how to download, exploit, and utilize it. Requesting command must have connection to one of the above networks for use. (1/2 hour)

Introduction to PLGR Navigation: A familiarization with how to navigate, select datums, and basic commands of the AN/PSN-11 (the PLGR). DMS has very few PLGRs, recommend unit have one PLGR per two students if this training is desired. (2 to 4 hours)

Catalogs and Distribution: How to identify and order products using a hardcopy (paper) catalog for both standard paper and digital products. Discover how catalogs are organized and the distribution process works. Discuss the effect of transition to DLA. Request unit has its own catalogs available to use. (2 hours, 3 hours with PE for Catalogs. ½ hour for brief overview of distribution issues)

Crisis Support: People think only products in the catalogs are available in a crisis. We define "crisis", look at some recent crisis operations, and discuss the function of the NIMA Crisis Management Team. The class will see various crisis response products. (1 hour)

Map Updating/Real Time Navigation: Introduces students with incorporation of GPs and a computer in order to perform real time navigation and map updating (1 hour).

ECDIS-N and DNC®: Informational brief on Electronic Chart Display and Information System - Navy, the policy letter, status of Digital Nautical Chart (DNC®) production and implementation of ECDIS-N. This would most likely flow into a Full Utility Navigation Demonstration (FUND)/DNC® demo. (1-2 hours)

Digital Data Exploitation Tools: Learn the different software tools that utilize NIMA digital data. We can provide copies, installation, initial training data sets, and training on lower end software packages in the Windows 95/NT/98 environment for users:

GEOTRANS - is datum transformation and coordinate conversion software that makes it easy to convert coordinates into differing datum's and coordinate systems. For example converting the Tokyo Datum into WGS 84 or convert Lat/Long coordinates into MGRS/UTM. It also allows file batch conversions, so the user can convert a file with many coordinates into another datum or coordinate system with a few button clicks.

Terrabase II - Army Engineer's terrain visualization software: Utilizes Digital Terrain Elevation Data (DTED®) Levels 1 and 2, Digital Elevation Models (DEMS), Controlled Image Base (CIB®), Compressed Arc Digitized Raster Graphics (CADRG), Arc Digitized Raster Graphics (ADRG), USGS Products, LANDSAT imagery, other digital imagery/aerial photography, and ERDAS Imagine files in a

UTM projection. Creates perspective views, line of sight analysis, fly-throughs, and other useful terrain visualization tools.

FalconView: Part of Air Force and Navy/Marine Corps Portable Flight Planning Software (PFPS) suite that has proven to be the most user friendly and versatile software package for exploitation of CADRG (scanned maps) and CIB® (10 & 5 meter (1 meter in next version) resolution unclassified imagery) for operational uses. Allows a GPs feed and poor man's moving map display. Is also a great tool to make and print briefing maps to scale or for PowerPoint use.

NIMAMUSE (MC&G Utility Software Environment): NIMAMUSE allows users with a 486+ PC to view, manipulate, or print NIMA digital products for mission planning. NIMA MUSE is great for briefing graphics and analyzing digital products.

Full Utility Navigation Demonstration (FUND): Software created to demonstrate Digital Nautical Chart (DNC®) and basic ECDIS-N functions. Displays DNC® and has basic marine navigation functions along with ability for a GPs feed.

ArcView: COTS Geographic Information System (GIs) produced by Environmental Systems Research Institute, Inc (ESRI) for the Windows 95/NT/98 environment that is extensively used within the military today. We cannot provide copies, but rather training on this highly versatile digital data exploitation tool.

.....

Where to find it:
☞For the latest **course descriptions and schedules**, access the DMS homepage at http://www.nima.mil/nimc/dms or call the DMS Registrar, at (703) 805-3213 [DSN 655].
☞Submit **GI&S training applications** to the Director, DMS, 5855 21St., Suite 106, Ft. Belvoir, VA 22060-5921.

ACKNOWLEDGMENTS

This handbook got its it start from the Naval Aviation Systems Handbook. Which was authored by CDR Zdenka Willis. We found a formula that worked and we plagiarized it for this handbook.

Mr. Jim Ayers, the champion of DNC and ECDIS, for the Navy. As he retires from NIMA, his service as a Captain, United States Navy, President of the International Hydrographic Bureau, and now as Chief Hydrographer of NIMA has been greatly appreciated. We would not be here without his efforts. THANK YOU.

A VERY SPECIAL THANKS to

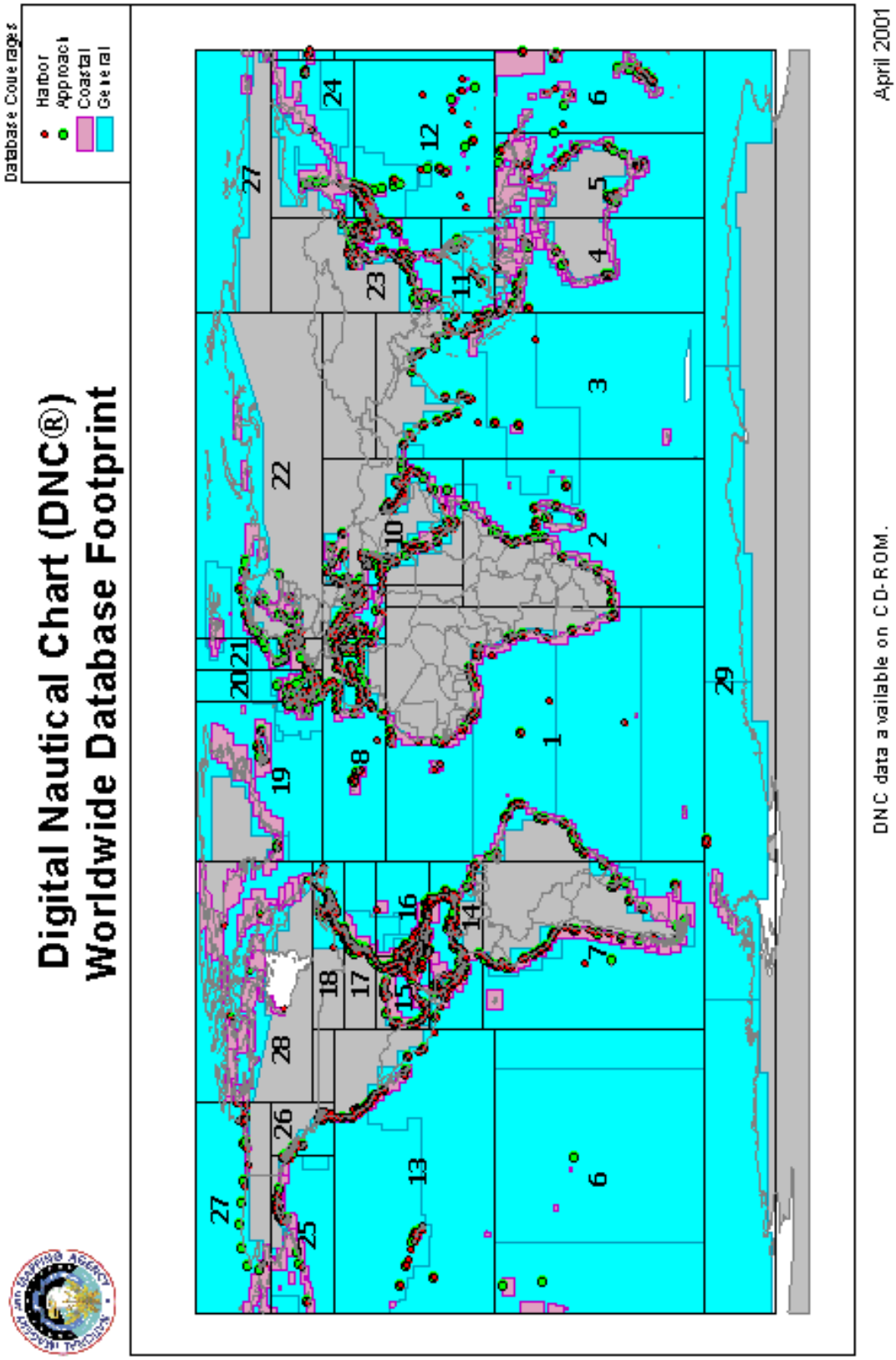
Zdenka S. Willis, CDR USN
James C. Goodson, NIMA
Edwin O. Danford NIMALO, Ret

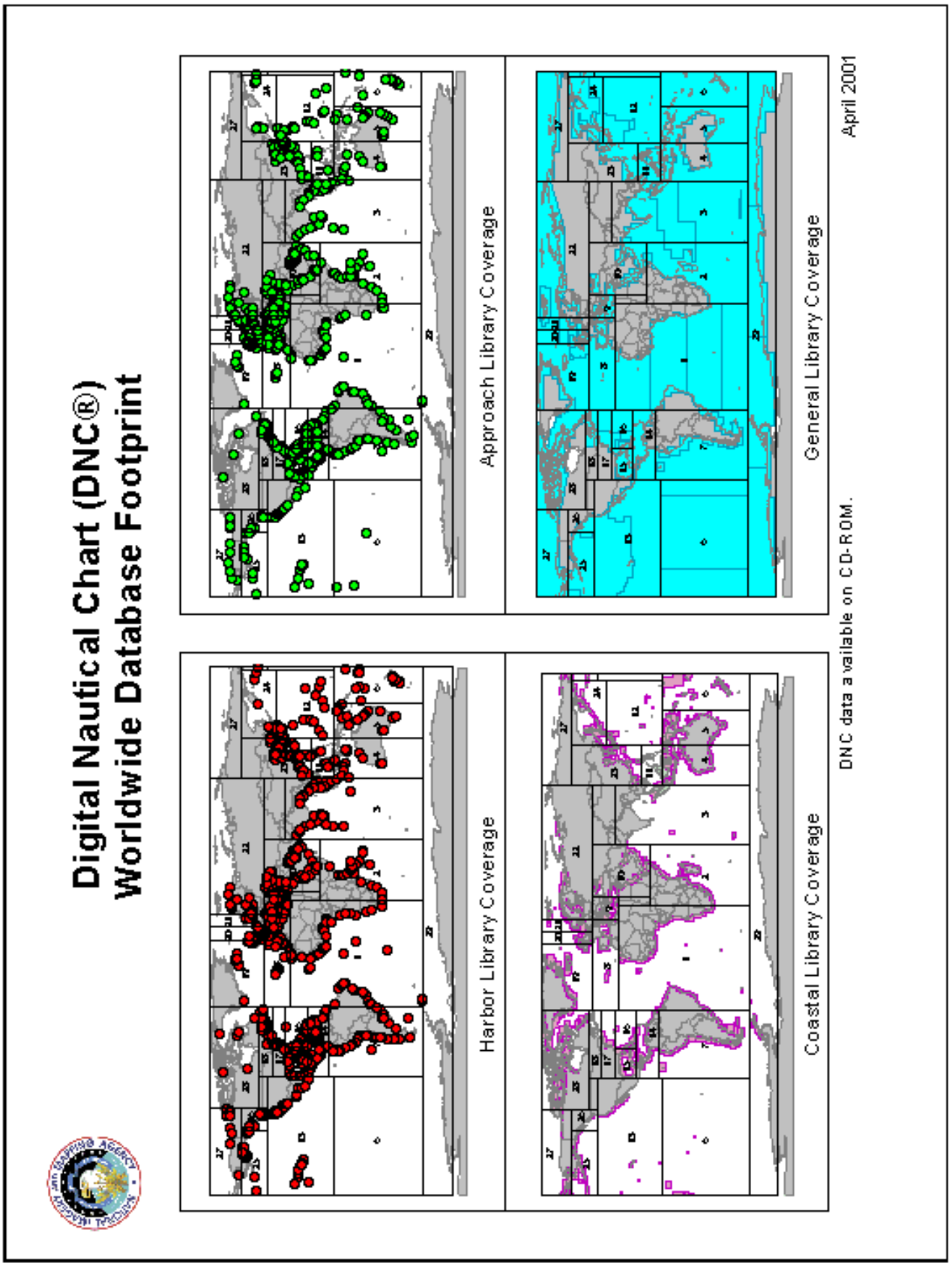
and especially -
Ms. Chris Wright of PSI Inc. who did the layout and designed the wonderful cover.

However, every error belongs to us.
So, how did we do? Does this handbook add any value to your work? Do you think it was worth the effort? Thanks in advance for your comments, questions and improvements. Keep sending them to:

Paul D. Witmer N096BN3 witmer.paul@hq.navy.mil

APPENDIX A


Database Coverages
Harbor
Approach
Coastal
General
Digital Nautical Chart (DNC®)
Worldwide Database Footprint
April 2001
DNC data available on CD-ROM.


Digital Nautical Chart (DNC®)
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Approach Library Coverage
General Library Coverage
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DNC data a vailable on CD-ROM.
April 2001

APPENDIX B

3140
Ser N00/8U5000076
17 Mar 98

From: Chief of Naval Operations

Subj: U.S. NAVY ELECTRONIC CHART DISPLAY AND INFORMATION SYSTEM POLICY.

Ref: (a) CNO/CMC ltr Ser 09/1U500942 of 1 Aug 91 "U.S. Navy/U.S. Marine Corps Positioning/Navigation Policy"
(b) OASD (C3I) memo "Development, Procurement, and Employment of DoD Global Positioning System (GPS) User Equipment" of 30 Apr 92
(c) IMO Resolution A.817(19) adopted on 23 Nov 95
(d) IEC 61174 "Maritime navigation and radio communication equipment and systems - ECDIS - Operation and performance standards, methods of testing and required test results" draft of Mar 97.

Encl.: (1) ECDIS-Navy

1. Purpose. To transition primary support of navigation and piloting on U.S. Navy vessels from paper charts to an electronic charting environment. This policy provides planning guidance for the Electronic Chart Display and Information System - Navy (ECDIS-N) consistent with reference (a).

2. Applicability. This policy applies to the development and procurement of systems that support ECDIS-N, and all U.S. Navy vessels that will use an ECDIS-N in support of navigation, piloting, and accurate positioning. While the interim use of ECDIS-N systems for enhanced situational awareness is acceptable, U.S. Navy vessels may not use ECDIS-N systems in lieu of the requirement to maintain paper charts until the ECDIS-N systems are tested, certified and approved for fleet introduction (initial operational capability) by the appropriate authority.

3. Background. Electronic databases, operating systems, and computer technology have advanced, and the widespread deployment of digital display systems to the fleet has now made it possible to employ electronic charts at sea. In addition, the advent of continuous and automated positioning systems, such as the Global Positioning System (GPS) and Inertial Navigation System (INS), has made it possible to take maximum advantage of electronic charting, eliminating many constraining aspects of navigation by paper chart while significantly advancing safety of navigation.

4. Policy. This policy directs a Navy transition from navigation by means of paper charts to navigation by means of digital charts within the ECDIS-N standards. This policy promulgates the minimum ECDIS-N standards (enclosure (1)) and delineates specific responsibilities of OPNAV, Fleet Commanders in Chief, and Commander, Operational Test and Evaluation Force (COMOPTEVFOR). ECDIS-N capability begins limited Fleet introduction in FY98 to enhance situational awareness and initiate the transition to a certified ECDIS-N system. The goal is full fleet implementation by FY05. The Navy requirement for paper charts from the National Imagery and Mapping Agency (NIMA) as the primary means of navigation will continue until all U.S. Navy vessels implement ECDIS-N. The Navy may also retain a limited requirement for paper charts beyond FY05 as one means of satisfying ECDIS-N backup requirements (Appendix 6 to Enclosure 1). The Navy must ensure interoperability among various ECDIS-N systems and between ECDIS-N systems and other systems. Navy will achieve interoperability by mandating standards and functional requirements for ECDIS-N and associated electronic charts:

a. Navy standard automated and continuous positioning systems and approved navigation and piloting procedures shall be used for position reference. In addition to accepting continuous position systems for navigation and piloting, EDCIS-N shall accept radar and visual navigation fix information. This policy is consistent with references (a) and (b).

b. Department of Defense (DoD) standard products and datum will be employed as follows:

- Standard products and services are defined as those which are produced by NIMA. NIMA produces all electronic charts on WGS-84, maintains these products, and provides them directly to the fleet.
- World Geodetic System-84 (WGS-84) is the standard datum.
- Vector Product Format (VPF) is the standard digital data format that will support ECDIS-N onboard all US Navy vessels.

c. The standard products that support navigation are defined as follows:

Digital Product	Paper Equivalent	Classification
Digital Nautical Chart (DNC™)	General, Coastal, Harbor, & Approach	Unclassified
Tactical Ocean Data (TOD) 0	OPAREA, Range markings	Distribution Limited
Tactical Ocean Data (TOD) 1	Bottom Contour	Confidential
Tactical Ocean Data (TOD) 2	Bathymetric Navigation Planning Chart (BNPC)	Secret
Tactical Ocean Data (TOD) 3	TBD	As required
Littoral Warfare Data (LWD)	Combat Chart	Confidential
Vector Database Update (VDU)	Notice to Mariners	Depends on product

d. ECDIS-N must incorporate safe navigation and piloting functionality at a minimum. Enclosure (1) defines the performance standards for ECDIS-N, which in conjunction with standard DoD digital navigation products will replace the use of paper charts. ECDIS-N functionality is based on reference (c), which is the International Maritime Organization (IMO) performance standards for the Electronic Chart Display and Information System (ECDIS) as established for civil shipping. U.S. Navy vessels are not required to comply with IMO resolutions. In setting standards in keeping with safe maritime operations, however, Navy will follow DoD mandates to use commercial standards wherever possible. Therefore, deviations from the civil guidance will be limited to those required for unique military applications and approved naval navigation and piloting procedures. All electronic charting data used for navigation must be maintained using the most current NIMA databases and updates available. Reference (d), IEC 61174, with modifications to bring it into compliance with enclosure (1), is the acceptable standard for testing ECDIS-N. Reference (c), and reference (d) (modified) are available from CNO(N096).

e. This policy letter does not take precedence over any DoD and Navy policy with regard to the Joint Technical Architecture (JTA) and the Defense Information Infrastructure-Common Operating Environment (DII-COE) compliance. At a minimum, ECDIS-N shall be DII-COE Level 5 compliant. Further, ECDIS-N shall be compliant with the DOD JTA.

5. Responsibilities.

a. The Director, Space, Information Warfare, Command and Control Directorate (N6) and Deputy Chief of Naval Operations for Resources, Warfare Requirements and Assessments (N8), shall:

(1) Serve as the resource sponsors for ECDIS-N systems;

(2) Identify programmatic requirements for implementation of ECDIS-N capability;

(3) Certify that ECDIS-N systems comply with the standards set forth in this policy prior to authorizing use of ECDIS-N systems in lieu of paper charts. The certification will be based on Operational Test and Evaluation results and implementation of Integrated Logistics Support. (This does not preclude the use of ECDIS-N systems prior to certification, provided that use is restricted to situational awareness only. Uncertified ECDIS-N systems may not be used in lieu of paper charts);

(4) Ensure that appropriate training is established for officers and enlisted personnel;

(5) Approve Fleet introduction and Initial Operational Capability for ECDIS-N systems under their cognizance; and,

b. The Director, Space, Information Warfare, Command and Control Directorate (N6) shall commit research, development, test and evaluation (RDT&E) funds to an ECDIS-N initiative that is a derivative of any existing N6 navigation program.

c. The Oceanographer of the Navy (N096) shall:

(1) Establish and maintain minimum standards for ECDIS-N and review future IMO resolutions and standards. Incorporate changes to this policy as appropriate;

(2) Support N6, N8, and all developmental activities in matters relating to Navy's use of standard navigation products defined by this policy;

(3) Validate all new Geospatial Information & Services (GI&S) requirements and coordinate the development of new standard DoD products, and;

(4) Support the Judge Advocate General of the Navy (N09J), in coordination with NIMA, in matters concerning international regulations and maritime law as related to navigation matters.

d. The Judge Advocate General of the Navy (N09J) shall ensure that uses of ECDIS-N prescribed by the Navy for its ships comply with applicable international legal obligations related to safe navigation. N09J shall apprise the Chief of Naval Operations and Fleet Commanders of changes to international law and regulations which are relevant to the Navy's use of electronic charts.

e. Fleet Commanders in Chief shall:

(1) Incorporate ECDIS-N into Fleet navigation Instructions;

(2) Develop ship's ECDIS-N certification plans; and,

(3) Serve as certifying authority for areas where ECDIS-N can be employed in lieu of paper charts. The policy authorizes Fleet Commanders to approve the use of ECDIS-N within geographical areas covered by GI&S products that meet ECDIS-N standards and updates.

f. COMOPTEVFOR shall evaluate the operational effectiveness and operational suitability of ECDIS-N systems and associated products and make recommendations regarding fleet introduction as appropriate.

6. The Assistant Secretary of the Navy for Research, Development, and Acquisition concurs with the policy contained herein.

7. Coordination. This letter has been coordinated with NIMA.

D. L. PILLING
Acting

APPENDIX C

THOSE INEVITABLE ACRONYMS

AGL	Above Ground Level
ANSI	American National Standards Institute
AUTODIN	Automatic Digital Network
BC	Bottom Contour
BNPC	Bathymetric Navigation Planning Chart
CADRG	Compressed ARC Digitized Raster Graphic
CASREP	Casualty Report
CDR	Commander
CD-ROM	Compact Disc - Read Only Memory
CEP	Circular Error Probable
CINC	Commander-In-Chief
CIO	Central Imagery Office
CJCS	Chairman, Joint Chiefs of Staff
CNN	Cable New Network
CNO	Chief of Naval Operations
CNMOC	Commander, Naval Meteorology and Oceanography Command
COMSAT	Commercial Satellite
COTS	Commercial Off The Shelf
DAFIF	Digital Aeronautical Flight Information File
DBDB	Digital Bathymetric Data Base
DC	District of Columbia
DDN	Defense Data Network
DepSO	Department Standardization Officer
DGPS	Differential Global Positioning System
DIA	Defense Intelligence Agency
DLA	Defense Logistics Agency
DLSS	Defense Logistics Standard System
DMA	Defense Mapping Agency
DMS	Defense Mapping School
DNC™	Digital Nautical Chart
DoD	Department of Defense
DoDAAC	Department of Defense Activity Address Code
DOP	Dilution of Precision
DSN	Defense Switched Network
DTED	Digital Terrain Elevation Data
DTG	Date Time Group
ECDIS	Electronic Chart Display and Information System
ECDIS-N	Electronic Chart Display and Information System - Navy
FUND	Full Utility Navigation Demonstration
FY	Fiscal Year
GB	Gigabyte
GI&S	Geospatial Information and Services

GIS	Geographic Information System
GOTS	Government Off The Shelf
GPS	Navstar Global Positioning System
HO	Hydrographic Office
HYSAS	Hydrographic Source and Assessment System
IEC	International Electrotechnical Committee
IFSAR	Interferometric Synthetic Aperture Radar
IHO	International Hydrographic Organization
IMO	International Maritime Organization
JCS	Joint Chiefs of Staff
K	Thousand
KB	Kilobyte
KSNM	Thousand Square Nautical Miles
km	kilometer
LWD	Littoral Warfare Database
M	Million
MADTRAN	Mapping Datum Transformation
MC&G	Mapping, Charting, and Geodesy
METOC	Meteorological/Oceanographic
MGRS	Military Grid Reference System
MIL-HDBK	Military Handbook
MIL-SPEC	Military Specification
MIL-STD	Military Standard
MILSTRIP	Military Standard Requisitioning and Issue Procedures
mm	millimeter
MS-DOS	Microsoft Disk Operating System
MSL	Mean Sea Level
MTF	Message Text Format
MTT	Mobile Training Team
MUSE	Mapping, Charting, and Geodesy Utility Software Environment
N096	Oceanographer of the Navy
NA	Not Applicable or Not Available
NAD 27	North American Datum 1927
NATO	North Atlantic Treaty Organization
NAVSEA	Naval Sea Systems Command
NAVINFONET	Navigation Information Network
NIMA	National Imagery and Mapping Agency
NIMA-COTN	NIMA - Customer Office Team - Navy
NIMALO	NIMA Liaison Officer
NITF	National Imagery Transmission Format
NMEA	National Marine Electronics Association
NOAA	National Oceanic Atmospheric Administration
NOS	National Ocean Service
NPIC	National Photographic Intelligence Center
NSFS	Naval Surface Fire Support
NSN	National Stock Number
NSS	Navigation Safety System
NtM	Notice To Mariners

OPNAVINST	Office of the Chief of Naval Operations Instruction
O&M,N	Operations and Maintenance Navy
OSD	Office of the Secretary of Defense
PC	Personal Computer
PDF	Portable Document Format
pixel	picture element
PLGR	Precise Lightweight Geopositional Receiver
QMCS	Senior Chief Quartermaster
RPF	Raster Product Format
RRS	Remote Replication System
RSI	Remotely Sensed Imagery
SEP	Spherical Error Probable
SOLAS	Safety Of Life At Sea
SPAWAR	Space and Naval Warfare Systems Command
STELLA	System To Estimate Latitude and Longitude Astronomically
TBD	To Be Determined
TOD	Tactical Ocean Data
TPF	Text Product Format
UIC	Unit Identification Code
UN	United Nations
UPS	Universal Polar Stereographic
US	United States
USCG	United States Coast Guard
USN	United States Navy
USIGS	United States Imagery and Geospatial System
USS	United States Ship
UTM	Universal Transverse Mercator
VDU	Vector Product Format Database Update
VPF	Vector Product Format
VPFS	Vector Product Format Symbology
WGS	World Geodetic System
WSC	Warrior Support Center
WVSPLUS®	World Vector Shoreline Plus

The Fine Print

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jē ī & ĕs

What is it?

a. Gouge for the alphabetically challenged
b. The latest release from OSAA (Office of the Secretary for Acronym Activity)
c. The lost letters of Atlantis
d. The way of the future for charts and maps

Don't know?

Then call the CNO N096 GI&S team for help

(better yet your nearest GI&S officer in the fleet)!

[The correct answer: d]